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MECHANICAL ARRANGEMENT OF SEMICONDUCTOR COMPONENTS CONNECTED IN PARALLEL

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[Abstract]

The invention describes a mechanical arrangement of semiconductor components that are connected in parallel, wherein said semiconductor components are respectively soldered on a separate printed circuit board in groups, and wherein several of these modules are connected in parallel by means of continuous conductor rails. In this case, the conductor rails simultaneously serve for conducting a current and for mechanically pressing the modules onto the heat sinks.

Description

The invention pertains to a mechanical arrangement for the field of power electronics, namely for forming electronic power switches or rectifier circuits of higher power rating. In this

case, it is required to connect in parallel several individual semiconductor chips. Semiconductor manufacturers offer so-called modules; these modules are components, in which several individual chips are already mounted on a common insulated cooling surface that is usually provided with screw connections on its upper side. The base plate of such a module is screwed onto a cooling surface in order to carry off heat. As convincing as this technical solution might appear, the main problem can be seen in the fact that the prices of these modules have for several years amounted to a multiple of the price of several smaller components with the same total current carrying capacity. Due to the intense competition in this field, numerous firms were forced to realize their high-current circuits by connecting several smaller semiconductor components in parallel. One such solution is, for example, described in Patent 40 05 333. Although this solution has proved very advantageous in practical applications, it still has significant disadvantages. First, this solution is associated with a high mounting expenditure because each individual semiconductor component has its own screw mounting. Second, the prices of the heat sink are relatively high because each threaded hole results in additional costs. Third, the high insulation requirements for the air gaps and the leakage paths cannot be fulfilled with the individual and direct screw-type mounting of the semiconductor components if it is intended to eliminate very expensive and complicated auxiliary cooling rails and the semiconductor components need to be directly mounted on the heat sink. When using 600 V d.c., a leakage path of 6 mm needs to be provided referred to the cooling surface. In modern semiconductor housings with an insulated screw mounting, this can only be realized with high expenditure. The solution according to the aforementioned patent consequently cannot be utilized for safety reasons if the heat sink needs to be at ground potential and one desires to eliminate auxiliary cooling rails. Another disadvantage can be seen in the fact that a separate printed circuit board that contains the respectively required number of semiconductor components is required for different current ranges. This results in high storage costs and a certain lack of flexibility because prior information as to how many printed circuit boards of each power rating need to be ordered and manufactured is required.

The invention is based on the objective of disclosing a significantly simpler and more flexible arrangement that consists of a building block system or modular system such that the storage costs can also be reduced. Depending on the required current range, a corresponding number of identical modules can be installed in one housing. The invention also aims to additionally reduce the mounting costs in comparison to the state of the art. It should be possible for the heat sinks to be at ground potential, with the heat sinks no longer being utilized for conducting current and as an electric connection. It should be possible for the semiconductor components to directly adjoin the main cooling surface without requiring auxiliary cooling rails. The requirements regarding the air gaps and the leakage paths need to be reliably fulfilled with

the modern semiconductor housings available on the market (e.g., TO247, TO3P, TO3PL) and the modern insulating foils. In contrast to the commercial modules of the semiconductor manufacturers, the new solution should make it possible to not only realize the semiconductor circuit in a modular fashion, but also the required surrounding field. For example, in a half bridge module of a resonant circuit, the back-up capacitors, the resonance or discharge capacitors, common parts of the base or gate control, etc., can be contained in one module according to the invention.

According to the invention, the aforementioned objective is attained due to the fact that a certain number of such semiconductor components is respectively arranged on a separate printed circuit board such that a module is formed, the fact that several identical modules are electrically connected to one another and connected in parallel by means of continuous conductor rails, the fact that the semiconductor components of a module adjoin a cooling surface with their cooling side and the first side of the printed circuit board of a module with their opposite housing side, and the fact that the conductor rails adjoin the printed circuit board on the other side and are tensioned against the cooling surface with, if so required, insulated mounting means such that the semiconductor components are pressed against the cooling surface.

If the heat sink needs to be insulated, an insulating foil is arranged between the semiconductor components and the cooling surface.

According to another advantageous embodiment, additional components of the respective circuit arrangement are mounted on the printed circuit boards of the modules such that an additional simplification of the parallel circuit is achieved. It is, for example, possible to provide RC protection wiring in rectifier modules or, for example, the back-up capacitors of the intermediate circuit, possible discharge circuits and parts of the base and gate control in half bridge modules such that each newly added module of the parallel circuit also analogously multiplies as many of the other required components of the selected circuit as possible.

In order to compensate tolerances caused by uneven sections, a slight deformation of the conductor rails or the heat sink and temperature-related deformations, it may be advantageous to arrange a permanently elastic foil (e.g., of silicone) between the printed circuit board and the semiconductor components. If the leakage paths are subject to strict requirements, this foil provides an additional safety play if the copper strips of the printed circuit board need to extend directly underneath the semiconductor components.

It may also be advantageous to install electrically conductive contact elements between the printed circuit board and the conductor rails, e.g., washers that contain furrows on both sides and improve the current transfer.

Diodes, bipolar transistors, MOS-FETs, IGBTs, MCTs or other modern components known from the field of power electronics may be used as semiconductor components.

The invention is described in greater detail below with reference to the figures. The figures show:

Figure 1, a view of the printed circuit boards of an arrangement according to the invention with three parallel modules, and

Figure 2, a side view of one individual mounted semiconductor component.

Figure 1 shows an exemplary design of a cooling surface 4, on which three modules 5 are mounted. In this case, each module 5 is equipped with four semiconductor components 1. Additional components 9 are also soldered onto the printed circuit board 2. The semiconductor components 1 are situated on the underside of the printed circuit board 2 and consequently illustrated with broken lines. The three modules 5 are connected to one another and connected in parallel by means of two long conductor rails 3. The contact between the conductor rails 3 and the copper strips of the printed circuit board 2 is achieved due to mechanical contact pressure. Due to this pressure, the semiconductor components 1 are also pressed against the cooling surface 4 in order to be cooled. The contact pressure is generated with mounting means 6 (e.g., screws) that tension the conductor rails 3 against the cooling surface 4 within orderly clearances. If so required, the mounting means 6 need to be insulated.

Figure 2 shows an exemplary side view. A thin insulating foil 7 is situated on the cooling surface 4. The heat transfer side of the semiconductor component 1 rests on this insulating foil. The permanently elastic foil 8 is arranged above the semiconductor component, with the printed circuit board 2 with its copper strips being arranged on top of the permanently elastic foil. The conductor rail 3 that compresses this laminated arrangement is situated on top of the printed circuit board. A contact element 10 that, for example, contains furrows or teeth can be installed between the printed circuit board 2 and the conductor rail 3 if so required in order to achieve a superior contact.

Claims

1. Mechanical arrangement for the field of power electronics, namely for forming electronic power switches or rectifier circuits, with said arrangement being realized by connecting in parallel several individual semiconductor components (1) of lower current carrying capacity, characterized by the fact that a certain number of such semiconductor components (1) is respectively arranged on a separate printed circuit board (2) such that modules (5) are formed, by the fact that several identical modules (5) are electrically connected to one another and connected in parallel by means of continuous conductor rails (3), by the fact that the semiconductor components (1) in a module(5) adjoin a cooling surface (4) with their cooling side and the first side of the printed circuit board (2) with their opposite housing side, and by the fact that the conductor rails (3) are arranged on the other side of the printed circuit board (2) and tensioned

against the cooling surface (4) with, if so required, insulated mounting means (6) such that the semiconductor components (1) are pressed against the cooling surface (4).

2. Mechanical arrangement according to Claim 1, characterized by the fact that an insulating foil (7) is arranged between the semiconductor components (1) and the cooling surface (4).

3. Mechanical arrangement according to Claim 1 or 2, characterized by the fact that additional components (9) of the respective circuit arrangement are mounted on the printed circuit boards (2) of the modules (5), e.g., RC protection wiring in a rectifier module or the back-up capacitors of the intermediate circuit, possible circuits and parts of the base and gate control in a half bridge switching module, namely such that each newly added module (5) of the parallel circuit also analogously multiplies the other required components (9) of the selected circuit.

4. Mechanical arrangement according to one of Claims 1-3, characterized by the fact that a permanently elastic foil (8) is arranged between the printed circuit board (2) and the semiconductor components (1).

5. Mechanical arrangement according to one of Claims 1-4, characterized by the fact that electrically conductive contact elements (10) are arranged between the printed circuit board (2) and the conductor rails (3).

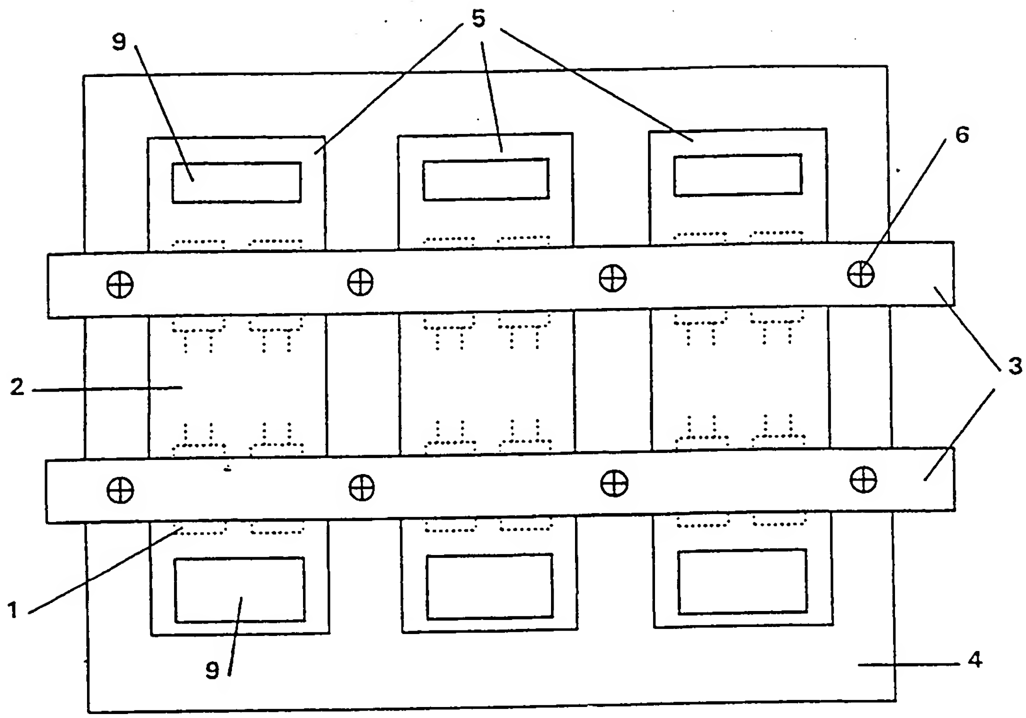

Fig. 1

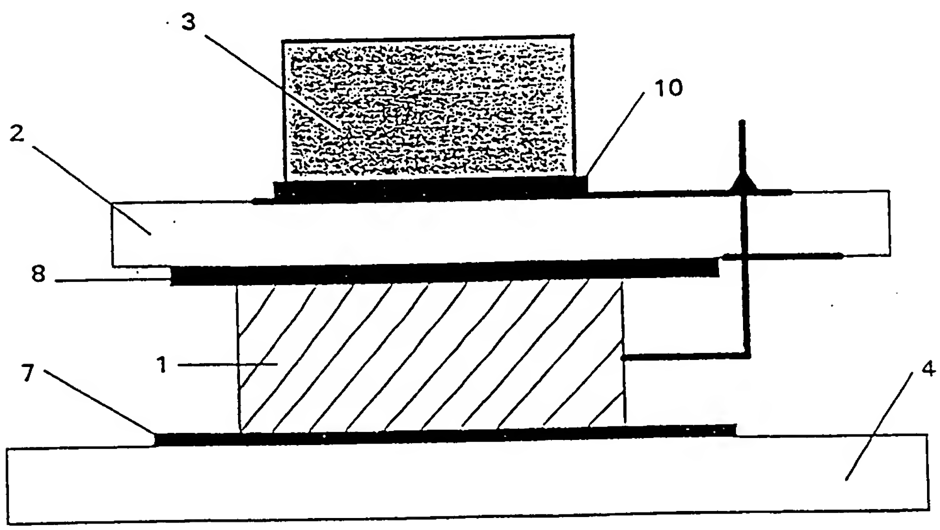

Fig. 2